Claims

1. A method of modulating an immune response in an animal comprising the step of administering to said animal a composition comprising

an antigen bearing target and further comprising a multifunctional molecule which comprises

a first amino acid sequence which can bind to a carbohydrate and a second amino acid sequence comprising a ligand for a cell surface polypeptide, wherein said ligand is chosen from the group: a ligand for a cytokine receptor, a ligand for CD40, a ligand for an adhesion molecule, a ligand for a defensin receptor, a ligand for a heat shock protein receptor, a ligand for a T cell costimulatory molecule, a ligand for a counterreceptor for a T cell costimulatory molecule.

2. The method of claim 1, wherein said animal is a mammal.

3. The method of claim 2, wherein said mammal is a human.

4. The method of claim 1, wherein said antigen bearing target comprises at least one of the following: a tumor antigen, a viral antigen, a bacterial antigen, a fungal antigen, a parasite antigen, a prion antigen, an antigen of an autoimmune disease.

5. The method of claim 1 wherein said antigen bearing target is a cell.

6. The method of claim 1, wherein said antigen bearing target is chosen from the group: a tumor cell, a virus, a bacterial cell, a fungal cell, a cell of a parasite, a prion, a mammalian cell, an insect cell, a polypeptide free of other cell-derived material.

7. The method of claim 5, wherein said antigen bearing target is pathogenic.

8. The method of claim 7, wherein said antigen bearing target is attenuated.

9. The method of claim 1, wherein said antigen bearing target is a cell which is substantially unable to divide.

10. The method of claim 1, wherein said multifunctional molecule is a fusion polypeptide.

11. The method of claim 10, wherein said first amino acid sequence is N-terminal to said second amino acid sequence.

12. The method of claim 10, wherein said first amino acid sequence is C-terminal to said second amino acid sequence.

13. The method of claim 5, wherein said multifunctional molecule is exogenous to said cell.

14. The method of claim 5, wherein said multifunctional molecule is endogenous to said cell and is encoded by a nucleic acid sequence comprised by the cell.

15. The method of claim 1, wherein said first amino acid sequence can bind to a sialic acid on a glycoprotein.

16. The method of claim 15, wherein said sialic acid comprises at least one of the following carbohydrate structures: N-acetylneuraminic acid, alpha-NeuNAc-[2->6]-Gal, alpha-NeuNAc-[2->6]-GalNAc, alpha-NeuNAc-[2->3]-Gal.

17. The method of claim 1, wherein said first amino acid sequence comprises a carbohydrate-binding domain of a naturally occuring lectin.

18. The method of claim 1, wherein said first amino acid sequence comprises at least about 10 contiguous amino acids of a hemagglutinin.

19. The method of claim 18, wherein said hemagglutinin is an influenza virus hemagglutinin.

20. The method of claim 19, wherein said contiguous amino acids of an influenza hemagglutinin are contiguous amino acids of an influenza hemagglutinin HA1 domain.

21. The method of claim 19, wherein said influenza virus is an influenza A virus.

22. The method of claim 21, wherein said influenza virus is of a subtype that infects humans.

23. The method of claim 21, wherein said influenza virus is of an H1 subtype.

24. The method of claim 23, wherein said influenza virus is from the strain A/PR/8/34.

25. The method of claim 24, wherein said influenza virus is of an H2 or H3 subtype.

26. The method of claim 19, wherein said influenza virus is of a subtype that does not infect humans.

27. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a mammalian cell surface polypeptide.

28. The method of claim 27, wherein said ligand for a cell surface polypeptide is a ligand for a mouse cell surface polypeptide.

29. The method of claim 27, wherein said ligand for a cell surface polypeptide is a ligand for a human cell surface polypeptide.

30. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a cell surface polypeptide of a leukocyte.

31. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a cell surface polypeptide of an antigen presenting cell.

32. The method of claim 31, wherein said ligand for a cell surface polypeptide is a ligand for a cell surface polypeptide of a professional antigen presenting cell.

33. The method of claim 30, wherein said ligand for a cell surface polypeptide is a ligand for a cell surface polypeptide of a dendritic cell.

34. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a mouse GM-CSF receptor.

35. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises at least about five contiguous amino acids of a mouse GM-CSF.

36. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises a mouse GM-CSF.

37. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a human GM-CSF receptor.

38. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises at least about five contiguous amino acids of a human GM-CSF.

39. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises a human GM-CSF.

40. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for an interleukin.

41. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for a mouse interleukin.

42. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for a human interleukin.

43. The method of claim 40, wherein said interleukin is chosen from the group: IL-1, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-12, IL-13, IL-14, IL-15, IL-16, IL-17, IL-18, IL-19, IL-20, IL-21, IL-22, IL-23, IL-24, IL-25.

44. The method of claim 40, wherein said ligand for a cell surface polypeptide comprises at least about 5 contiguous amino acids of an interleukin.

45. The method of claim 44, wherein said interleukin is chosen from the group: IL-1, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-12, IL-13, IL-14, IL-15, IL-16, IL-17, IL-18, IL-19, IL-20, IL-21, IL-22, IL-23, IL-24, IL-25.

46. The method of claim 40, wherein said ligand for a cell surface polypeptide comprises an interleukin.

47. The method of claim 46, wherein said interleukin is chosen from the group: IL-1, IL-2, IL-3, IL-4, IL-5, IL-6, IL-7, IL-8, IL-9, IL-10, IL-12, IL-13, IL-14, IL-15, IL-16, IL-17, IL-18, IL-19, IL-20, IL-21, IL-22, IL-23, IL-24, IL-25.

48. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for a chemokine.

49. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for a mouse chemokine.

50. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for a human chemokine.

51. The method of claim 48, wherein said chemokine is a C-C cytokine.

52. The method of claim 48, wherein said chemokine is a C-X-C cytokine.

53. The method of claim 48, wherein said cell surface polypeptide is chosen from the group: CXCR-1, CXCR-2, CXCR-3, CXCR-4, CCR-1, CCR-2, CCR-3, CCR-4, CCR-5, CCR-6, CCR-7, CCR-8.

54. The method of claim 48, wherein said chemokine is chosen from the group: 9E3, AMCF, beta-thromboglobulin, ENA-78, eotaxin, eotaxin-2, IP-10, KC, LIX, mig, MGSA, mob-1, NAP-2, NAP-3, NAP-4, PBSF, MGSA, mouse KC, MIP-2, MIP-1 alpha, NAP-2, ENA-78, GCP-2, ACT-2, C10, CCF18, DC-CK1, ELC, Exodus, FIC, GDCF, GDCF-2, HC-21, HCC-1, I-309, JE, LAG-1, MARC, MCAF, MCP-1, MCP-2, MCP-3, MCP-4, MCP-5, MRP-2, RANTES SDF, TARC, ATAC, Ltn, SCM-1, neurotactin.

55. The method of claim 48, wherein said ligand for a cell surface polypeptide comprises at least about 5 contiguous amino acids of a chemokine.

56. The method of claim 55 wherein said chemokine is chosen from the group: 9E3, AMCF, beta-thromboglobulin, ENA-78, eotaxin, eotaxin-2, IP-10, KC, LIX, mig, MGSA, mob-1, NAP-2, NAP-3, NAP-4, PBSF, MGSA, mouse KC, MIP-2, MIP-1 alpha, NAP-2, ENA-78, GCP-2, ACT-2, C10, CCF18, DC-CK1, ELC, Exodus, FIC, GDCF, GDCF-2, HC-21, HCC-1, I-309, JE, LAG-1, MARC, MCAF, MCP-1, MCP-2, MCP-3, MCP-4, MCP-5, MRP-2, RANTES SDF, TARC, ATAC, Ltn, SCM-1, neurotactin.

57. The method of claim 48, wherein said ligand for a cell surface polypeptide comprises a chemokine.

58. The method of claim 57, wherein said chemokine is chosen from the group: 9E3, AMCF, beta-thromboglobulin, ENA-78, eotaxin, eotaxin-2, IP-10, KC, LIX, mig, MGSA, mob-1, NAP-2, NAP-3, NAP-4, PBSF, MGSA, mouse KC, MIP-2, MIP-1 alpha, NAP-2, ENA-78, GCP-2, ACT-2, C10, CCF18, DC-CK1, ELC, Exodus, FIC, GDCF, GDCF-2, HC-21, HCC-1, I-309, JE, LAG-1, MARC, MCAF, MCP-1, MCP-2, MCP-3, MCP-4, MCP-5, MRP-2, RANTES SDF, TARC, ATAC, Ltn, SCM-1, neurotactin.

59. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for an interferon.

60. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for a mouse interferon.

61. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a receptor for a human interferon.

62. The method of claim 59, wherein said interferon is chosen from the group: an interferon-alpha, an interferon-beta, an interferon gamma.

63. The method of claim 59, wherein said ligand for a cell surface polypeptide comprises at least about 5 contiguous amino acids of an interferon.

64. The method of claim 63, wherein said interferon is chosen from the group: an interferon-alpha, an interferon-beta, an interferon gamma.

65. The method of claim 59, wherein said ligand for a cell surface polypeptide comprises an interferon.

66. The method of claim 65, wherein said interferon is chosen from the group: an interferon-alpha, an interferon-beta, an interferon gamma.

67. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a mouse TNF-alpha receptor.

68. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises at least about five contiguous amino acids of a mouse TNF-alpha.

69. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises a mouse TNF-alpha.

70. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a human TNF-alpha receptor.

71. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises at least about five contiguous amino acids of a human TNF-alpha.

72. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises a human TNF-alpha.

73. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a mouse flt-3 receptor.

74. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises at least about five contiguous amino acids of a mouse flt-3.

75. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises a mouse flt-3.

76. The method of claim 1, wherein said ligand for a cell surface polypeptide is a ligand for a human flt-3 receptor.

77. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises at least about five contiguous amino acids of a human flt-3.

78. The method of claim 1, wherein said ligand for a cell surface polypeptide comprises a human flt-3.

79. The method of claim 10, wherein said fusion polypeptide further comprises a linker interposed between said first and second amino acid sequences.

80. The method of claim 79, wherein said linker has the formula $(Gly_xSer)_n$, wherein n is an integer between 1 and 15, and x is an integer between 1 and 10.

81. The method of claim 1, wherein said composition comprises said multifunctional molecule bound to a carbohydrate on said antigen bearing target.

82. The method of claim 1, in which at least some of said multifunctional molecule is not bound to said antigen bearing target.